

Forces and Motion

PS-5 The student will demonstrate an understanding of the nature of forces and motion.

PS-5.4 Use the formula $a = (v_f - v_i)/t$ to determine the acceleration of an object.

Taxonomy Level: 3.2-C Apply Procedural Knowledge

Key Concepts:

Acceleration

Initial velocity

Final velocity

Elapsed time

Previous/Future knowledge: In 8th grade, students analyze the effects of forces (including gravity and friction) on the speed and direction of an object (8-5.3) and predict how varying the amount of force or mass will affect the motion of an object (8-5.4). In Physical Science students are introduced to the concept of acceleration (PS5.3). In Physics students will derive equations to analyze circular motion, trajectory motion, and complex vector problems, all of which begin with a fundamental understanding of the equation introduced here: $a = (v_f - v_i)/t$

The purpose of this indicator is to introduce Physical Science students to the mathematical aspects of acceleration. By calculating, using dimensional analysis in the calculation of acceleration, students will see that the final units for acceleration are m/s/s or m/sec².

It is essential for students to

- Interpret a word problem, or laboratory data, involving the motion of an object that is accelerating in one direction and determine the “given” information:
- Differentiate velocity from speed if the direction is given. If velocity is given, students should record the direction.
- Differentiate initial velocity (speed) from final velocity (speed) from the context of the problem.

Teacher note: As this is an introduction to the mathematical application of the concept of acceleration, the units given to students should be consistent. (The units for initial and final velocity should be the same.)

Students need to list the given variables using the correct units:

Variable	Symbol	Examples of units for velocity (or speed)	
Initial velocity (or speed)	$v_i =$ distance/time	5.0 m/s east (5.0 m/s)	5.0 km/h east (5.0 km/h)
Final velocity (or speed)	$v_f =$ distance/time	2.0 m/s east (2.0 m/s)	2.0 km/s east (2.0 m/s)
Elapsed time	t	15 s	15 s

It is essential for students to

- Use the equation $a = (v_f - v_i)/t$ to solve for acceleration only, not for v_f or v_i .
- Substitute the correct values into the equation, including the correct units.
- Mathematically solve the problem, using dimensional analysis to derive the units of the answer. (see dimensional analysis PS-1.5)
- Check to make sure that the units calculated from the dimensional analysis match the appropriate units for the acceleration (distance/time divided by time or distance divided by time-squared).
- Understand that negative acceleration means that velocity is decreasing.

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Teacher note: In Physical Science, we will restrict negative acceleration to the case of an object that is slowing down. There are other scenarios that are considered negative acceleration, but they will be addressed in physics.

It is not essential for students to

- Solve problems to convert Standard English units to metric units.
- Solve problems involving scientific notation.
- Solve the equation for initial velocity, final velocity, change in velocity, or elapsed time.

Assessment Guidelines:

The objective of this indicator is to use the acceleration formula to determine acceleration of an object, therefore, the primary focus of assessment should be to apply the acceleration formula to a novel word problem or set of experimental data, not just problems that are familiar.

In addition to use, assessments may require that students:

- Recognize when the formula should be applied;
- Identify the appropriate units for the solution to the problem;
- Compare data using the formula.